Shallow Ground-Water Quality in an Agricultural Area of the Lower Coastal Plain of South Carolina, 1997

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Santee River Basin and Coastal Drainages Study Unit

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COVER PHOTO: Corn field near Orangeburg, South Carolina
Photograph by Eric J. Reuber, U.S. Geological Survey

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By Eric J. Reuber

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Columbia, South Carolina
2001

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FOREWORD

The U.S. Geological Survey (USGS) is committed to serve the Nation with accurate and timely scientific information that helps enhance and protect the overall quality of life, and facilitates effective management of water, biological, energy, and mineral resources. Information on the quality of the Nation's water resources is of critical interest to the USGS because it is so integrally linked to the long-term availability of water that is clean and safe for drinking and recreation and that is suitable for industry, irrigation, and habitat for fishes and wildlife. Escalating population growth and increasing demands for these multiple water uses make water availability, now measured in terms of quantity *and* quality, even more critical to the long-term sustainability of our communities and ecosystems.

The USGS implemented the National Water-Quality Assessment (NAWQA) program to support national, regional, and local information needs and decisions related to water-quality management and policy. Shaped by and coordinated with ongoing efforts of other Federal, State, and local agencies, the NAWQA Program is designed to answer: What is the condition of our Nation's streams and ground water? How are the conditions changing over time? How do natural features and human activities affect the quality of streams and ground water, and where are those effects most pronounced? By combining information on water chemistry, physical characteristics, stream habitat, and aquatic life, the NAWQA Program aims to provide science-based insights for current and emerging water issues. Program results can contribute to informed decisions that result in practical and effective water-resource management and strategies that protect and restore water quality.

Since 1991, the NAWQA Program has implemented interdisciplinary assessments in more than 50 of the Nation's most important river basins and aquifers, referred to as "study units." Collectively, these study units account for more than 60 percent of the overall water use and population served by public-water supply, and are representative of the Nation's major hydrologic landscapes, priority ecological resources, and agricultural, urban, and natural sources of contamination.

Each assessment is guided by a nationally consistent study design and methods of sampling and analysis. The assessments thereby build local knowledge about water-quality issues and trends in a particular stream or aquifer while providing an understanding of how and why water quality varies regionally and nationally. The consistent, multiscale approach helps to determine if certain types of water-quality issues are isolated or pervasive, and allows direct comparisons of how human activities and natural processes affect water quality and ecological health in the Nation's diverse geographic and environmental settings. Comprehensive assessments on pesticides, nutrients, volatile organic compounds, trace metals, and aquatic ecology are developed at the national scale through comparative analyses of the study-unit findings.

The USGS places high value on the communication and dissemination of credible, timely, and relevant science so that the most recent and available knowledge about water resources can be applied in management and policy decisions. We hope this NAWQA publication will provide you the needed insights and information to meet your needs, and thereby foster increased awareness and involvement in the protection and restoration of our Nation's waters.

The NAWQA Program recognizes that a national assessment by a single program cannot address all water-resource issues of interest. External coordination at all levels is critical for a fully integrated understanding of watersheds and for cost-effective management, regulation, and conservation of our Nation's water resources. The program, therefore, depends extensively on the advice, cooperation, and information from other Federal, State, interstate, tribal, and local agencies, nongovernment organizations, industry, academia, and other stakeholder groups. The assistance and suggestions of all are greatly appreciated.

Robert M. Hirsch
Associate Director for Water

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FIGURE

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CONVERSION FACTORS, TEMPERATURE, AND VERTICAL AND HORIZONTAL DATUM

Multiply	By	To obtain
inch (in.)	25.40	millimeter
foot (ft)	0.3048	meter
pound (lb)	0.4535	kilogram
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer

Temperature can be converted between degrees Fahrenheit (°F) and degrees Celsius (°C) as follows:
°F = (°C x 9/5) + 32 °C = (°F–32) x 5/9

Sea level refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Horizontal coordinate information is referenced to the North American Datum of 1988 (NAD88).

ADDITIONAL ABBREVIATIONS AND ACRONYMS

AGLUS	agricultural land-use study area
MDL	method detection limit
mg/L	milligram per liter
µg/L	microgram per liter
mL	milliliter
MRL	Minimum reporting level
µS/cm	microsiemens per centimeter
NAWQA	National Water-Quality Assessment Program
NWQL	National Water Quality Laboratory
PVC	polyvinyl chloride
QA/QC	quality assurance and quality control
SANT	Santee River Basin and Coastal Drainages study unit
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey

Shallow Ground-Water Quality in an Agricultural Area of the Lower Coastal Plain of South Carolina, 1997

By Eric J. Reuber

Abstract

Ground-water-quality samples were collected from 30 shallow monitoring wells located in agricultural areas of the lower Coastal Plain of South Carolina during the summer of 1997 as part of the U.S. Geological Survey National Water-Quality Assessment Program in the Santee River Basin and Coastal Drainages study unit. The wells were completed in sand to clayey sand sediments of the surficial aquifer and sampled one time for selected field properties, and nutrient, major ion, and pesticide concentrations. This report contains the results of the sampling effort.

INTRODUCTION

In 1991, the U.S. Geological Survey (USGS) implemented the National Water-Quality Assessment (NAWQA) Program. Long-term goals of the NAWQA Program include describing the status and trends in the quality of the Nation's surface- and ground-water resources and identifying major natural and anthropogenic factors that affect the quality of these water resources (Hirsch and others, 1988). To meet these goals, nationally consistent data useful to policy makers, scientists, and managers are being collected and analyzed at more than 50 of the Nation's largest river basins and aquifers, which are termed NAWQA study units.

The Santee River Basin and Coastal Drainages (SANT) study unit includes parts of the Coastal Plain, Piedmont, and Blue Ridge physiographic provinces in North and South Carolina (fig. 1). Assessment activities began in 1994. Although agriculture is not the predominant land use in the Coastal Plain of the SANT (table 1), it is a major land use of concern in relation to water quality. Activities associated with agriculture introduce a potential for nutrients and pesticides to leach into ground water or be discharged to surface water, either of which could impact drinking-water supplies or cause impairment of surface water for designated uses. Historical water-quality data for the shallow aquifers in the SANT study unit are limited. To address these concerns, the USGS conducted an investigation of shallow ground-water quality in agricultural areas in the Coastal Plain of South Carolina as part of SANT study unit activities. The study area (fig. 1) is referred to throughout this report as the agricultural land-use study area (AGLUS).

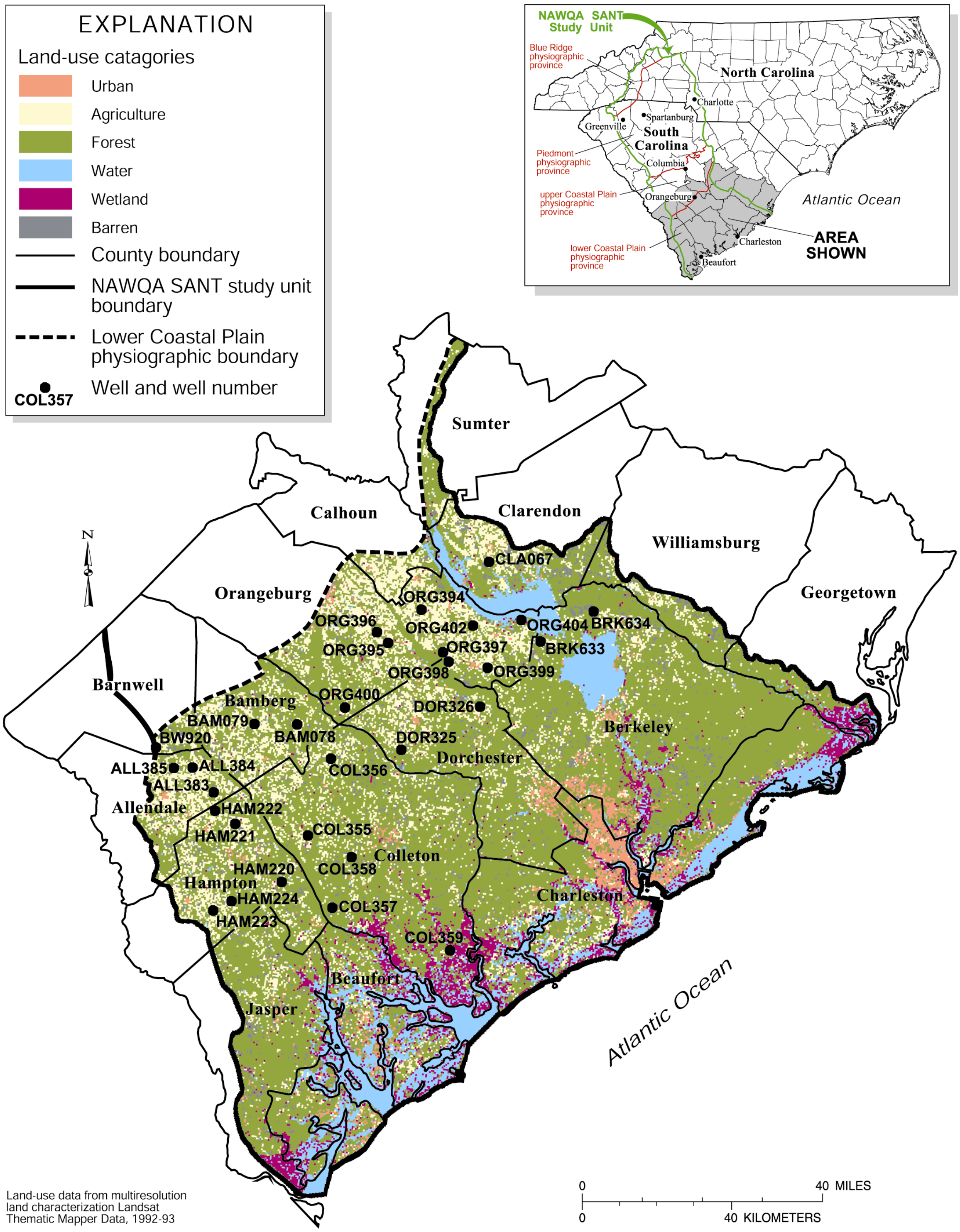

Figure 1. Land use and locations of monitoring wells in the agricultural land-use study area, lower Coastal Plain of South Carolina, 1997. [NAWQA, National Water-Quality Assessment Program; SANT, Santee River Basin and Coastal Drainages study unit.]

Table 1. Land use in the agricultural land-use study area, lower Coastal Plain of South Carolina, 1994

[Data modified from U.S. Geological Survey, 1994]

Land use	Square miles	Percentage[1]
Forest	2,910	40.0
Wetland	2,060	28.3
Agriculture	1,720	23.7
Water	330	4.5
Urban	220	3.0
Barren	29	0.4

[1] Total does not equal 100 percent due to rounding.

Purpose and Scope

This report presents ground-water-quality data collected from the surficial aquifer in an agricultural land-use area of the lower Coastal Plain of South Carolina. Thirty shallow monitoring wells (fig. 1) were installed in the surficial aquifer during the spring of 1997. Ground water was sampled once from each well during the summer of 1997 and analyzed for selected field properties, nutrients, major ions, and pesticides.

Description of Study Area

The SANT study unit (fig. 1) encompasses nearly 24,900 mi^2 in the Blue Ridge, Piedmont, and Coastal Plain physiographic provinces, and includes parts of North Carolina (4,700 mi^2) and South Carolina (20,200 mi^2). The SANT study unit contains agricultural lands, forests, wetlands, and five major metropolitan areas—Greenville, Spartanburg, Columbia, and Charleston, South Carolina, and Charlotte, North Carolina. The AGLUS, located in the lower Coastal Plain of South Carolina, is composed of all or parts of 16 counties (fig. 1) and covers approximately 7,270 mi^2. Average monthly temperatures in the lower Coastal Plain range from 50 °F in December to 81 °F in July. Average annual precipitation for the AGLUS is about 50 inches (in.), and nearly 50 percent of the rainfall occurs between June and September (South Carolina Water Resources Commission, 1983).

Land Use and Land Cover

Land use in the AGLUS (table 1) is dominated by forests (40.0 percent), wetlands (28.3 percent), and agriculture (23.7 percent) (U.S. Geological Survey, 1994). Agriculture in the AGLUS is characterized by pastures and a diversity of crops, such as corn, soybeans, cotton, tobacco, and sorghum. Corn and soybeans, the most prevalent crops, are planted in approximately 20 percent of the AGLUS and are commonly rotated with each other (South Carolina Agricultural Statistics Service, 1998). Many of these crops are irrigated. Urban land represents 3 percent of total land use in the AGLUS study area. Urban areas and agriculture predominate in well-drained areas, whereas forests and wetlands are concentrated in and along stream floodplains and carolina bays. Forested lands include natural regrowth of previously logged and agricultural areas, intensively managed forests, and forested wetlands.

Hydrogeologic Setting and Water Use

Six major aquifers underlie the lower Coastal Plain and are used for domestic and agricultural purposes within the SANT study unit. In descending order, the aquifers are the surficial, Tertiary sand, Upper Floridan, Black Creek, Middendorf, and Cape Fear (Aucott and others, 1986). Several rural community supplies and almost all private domestic supplies in the AGLUS rely on wells that obtain water from the deeper aquifers. This investigation addresses only water-quality conditions in the shallow surficial aquifer.

The surficial aquifer is present throughout much of the lower Coastal Plain, and overlies the Upper Floridan aquifer in the eastern part and the Tertiary sand aquifer in the western part of the AGLUS (Aucott and others, 1986). The surficial aquifer consists of sand, clay, and shells. In general, the thickness of these sediments ranges from 15 to 30 ft, except in Charleston County where the thickness ranges from 40 to 65 ft.

Sediments forming the surficial aquifer in the lower Coastal Plain generally consist of quartz sand and minor amounts of silicate minerals interbedded with silt and clay lenses. The clay lenses commonly contain pyrite and lignite. These sediments are

generally acidic, having a median pH value of about 4.5; pH generally increases with depth, reflecting the presence of carbonate minerals in shell material found in deeper sediments (Aucott and others, 1986).

The surficial aquifer is recharged by precipitation. Shallow ground water discharges through localized flow paths to nearby streams, ponds, and ditches. In many agricultural areas, natural drainage patterns have been altered with tile drains, drainage ditches, and by channelization of streambeds to improve agricultural land use. Water levels in the surficial aquifer range from land surface in floodplain areas to approximately 20 ft below land surface.

Most major municipalities in the SANT, and hence the AGLUS, rely on surface water as the major source for drinking-water supplies. Public and domestic supplies account for about two-thirds of the withdrawal, and agriculture represents nearly the other third (Stringfield, 1987).

DATA-COLLECTION METHODS

Standardized protocols within the NAWQA Program were used to choose well locations and sample ground water at selected sites (Koterba and others, 1995). Thirty wells were installed during May and June 1997 and water-quality sampling was completed between July and September 1997.

Monitoring Well Location and Installation

Wells were located in areas within or directly adjacent to agricultural areas. Drilling locations for monitoring wells were selected based on NAWQA well site-selection criteria (Lapham and others, 1995). The thirty wells were located in a randomized, areally distributed pattern in the AGLUS area of the lower Coastal Plain by using a site-selection program described by Scott (1990). Ancillary land-use and land-cover data were collected for each well according to Koterba (1998). Field reconnaissance and aerial photos were used to collect detailed land-use data within 1,600 ft of each well. In agricultural areas, land uses were subdivided into individual crop types present at the time of the site visit. In addition to specific crops, agricultural areas could include livestock farms, roads, orchards, and farm-related infrastructures that include houses, small gardens, barns, silos, and service roads on the farm.

Boreholes were drilled using 3-in-diameter solid-stem augers. No core recovery was available with this method of drilling and only limited cuttings were recovered. Wells were constructed with threaded 2-in-diameter, 5- or 10-ft-long schedule 40 polyvinyl chloride (PVC) casing. Casings were equipped with 5- or 10-ft-long, slotted (0.010 in.) PVC screens tipped with flush-threaded PVC drive-points. The tops of the screens generally were placed 2 to 5 ft below the water table. In cases where natural sand did not completely fill the borehole annular space surrounding the well screen, commercially prepared washed sand was added to a level approximately 2 ft above the top of the well screen. The remaining annular space was grouted with bentonite pellets to within 2 ft of land surface. The top 2 ft of each borehole was grouted to land surface with mortar. To protect the PVC wellhead, 3-in-diameter schedule 40 steel outer casings with locking caps were set into the mortar. All wells were constructed in accordance with South Carolina Department of Health and Environmental Control (1985) guidelines and NAWQA Program protocols for monitoring wells (Lapham and others, 1995). Well development took place within 15 days of installation by using a surge plunger or bailer to force water to flow in and out of the screened interval by moving the plunger or bailer up and down in the well casing. Well construction data are provided in table 2.

Field Data-Collection Methods

Wells were sampled for a variety of constituents. In addition to field properties (water temperature, specific conductance, dissolved-oxygen concentration, and pH), water samples were analyzed for selected major ions, nutrients, and pesticides. Prior to sampling, at least three casing volumes of water were pumped from the wells. Stability of the water chemistry was verified through periodic measurements of water temperature, specific conductance, dissolved-oxygen concentration, and pH while purging the wells. Samples were collected using Teflon, Viton, and stainless-steel tubing and fittings. Water samples were shipped to the USGS National Water Quality Laboratory (NWQL) in Denver, Colorado, following NAWQA protocols (Koterba and others, 1995).

Table 2. Well characteristics and field properties for ground-water samples from 30 monitoring wells in the agricultural land-use study area, lower Coastal Plain of South Carolina, 1997

[°C, Celsius; µS/cm, microsiemens per centimeter; mg/L, milligram per liter]

County well number (fig. 1)	U.S. Geological Survey well number	Land-surface elevation at well, in feet above sea level	Well depth, in feet below land surface	Screened interval, in feet below land surface	Water depth, in feet below land surface	Water temperature, (°C)	Specific conductance, (µS/cm at 25 °C)	Dissolved oxygen, (mg/L)	Water pH
ALL383	330051081092501	16	17	12-17	5.2	19.0	186	7.1	3.9
ALL384	330422081130601	16	20	15-20	7.7	19.5	165	5.5	4.2
ALL385	330417081162201	21	21	16-21	6.3	17.5	156	7.0	4.6
BAM078	331038080545601	13	17	12-17	9.5	23.0	264	7.5	5.4
BAM079	331043081022101	15	30	20-30	20.0	22.0	238	8.8	4.0
BRK633	332224080123601	88	20	16-20	13.7	20.0	248	3.4	7.1
BRK634	332641080032201	78	20	15-20	13.3	19.5	53	6.6	5.1
BW920	330715081192501	25	27	22-27	18.8	17.0	161	7.9	4.6
CLA067	333358080213001	11	25	22-25	22.3	20.0	160	8.1	4.1
COL355	325435080530601	80	30	25-30	18.3	19.0	190	7.4	4.4
COL356	330540080490701	10	18	13-18	7.1	18.5	8.3	7.3	7.7
COL357	324412080485501	52	25	15-25	16.8	21.0	69	7.8	4.2
COL358	325129080453601	84	17	12-17	6.4	23.0	114	1.9	4.1
COL359	323759080283701	13	13	3-13	5.4	18.0	202	1.4	4.4
DOR325	330656080365201	84	15	10-15	8.2	24.0	224	5.8	6.1
DOR326	331305080231301	90	18	13-18	12.4	21.5	92	5.7	4.3
HAM220	324754080573801	85	20	10-20	8.9	21.0	76	5.9	5.0
HAM221	325618081054101	11	17	12-17	12.2	27.5	98	3.4	4.6
HAM222	325812081090901	10	24	19-24	14.7	20.5	220	9.7	4.1
HAM223	324349081092801	10	17	12-17	11.1	22.0	31	5.2	4.6
HAM224	324507081061901	11	13	3-13	10.2	22.5	48	0.5	5.1
ORG394	332706080332001	15	17	7-17	9.4	21.5	42	5.7	4.6
ORG395	332355080410401	15	19	9-19	13.7	21.0	438	4.4	4.0
ORG396	332219080390501	13	13	9-13	9.8	23.5	239	5.3	4.0
ORG397	332056080293501	85	22	17-22	11.2	22.0	248	5.0	6.7
ORG398	331934080283701	88	21	16-21	10.8	22.5	59	0.2	5.0
ORG399	331842080215301	92	21	16-21	13.7	21.5	270	5.8	3.8
ORG400	331303080464101	14	27	22-27	5.9	20.0	322	0.4	7.5
ORG402	332446080242201	12	19	14-19	12.8	21.0	67	3.5	4.4
ORG404	332534080155701	78	21	16-21	8.4	21.0	234	0.2	6.4

Analytical Methods

Ground-water samples collected for this study were analyzed using methods described by Fishman and Friedman (1985), Brenton and Arnett (1993), Zaugg and others (1995), and Werner and others (1996). The USGS NWQL reports all analytical concentrations if all quality-control and methods criteria are met. The minimum concentration of a constituent that can be identified, measured, and reported with 99 percent confidence that the analyte concentration is greater than zero for a given matrix containing the analyte is called the method detection limit (MDL) (U.S. Geological Survey, 1999). At the MDL concentration, the risk of a false positive is predicted to be no more than 1 percent. Pesticides that are positively identified at concentrations less than the MDL are reported by the NWQL as estimated values. Major ions, nutrients, and dissolved-organic carbon are reported with minimum reporting levels (MRLs), which take into account MDLs and are based on the laboratory's best judgement of the concentration that can be reliably reported using a given analytical method (U.S. Geological Survey, 1999).

Quality Assurance and Quality Control

In addition to the samples collected from each of 30 wells, an additional 10 percent of samples were processed to ensure quality assurance/quality control (QA/QC) during the sampling and analytical processes. Three field blanks and one replicate sample were collected in accordance with NAWQA protocols (Koterba and others, 1995). Blanks aid in evaluating possible contamination by the equipment. Replicates aid in analyzing the precision of the sampling techniques and laboratory methods. The NWQL maintains its own internal program of blank, replicate, and spike samples to assure accurate water-quality analyses (Pritt and Raese, 1995).

HYDROLOGIC AND WATER-QUALITY DATA

Water from each of 30 wells was collected during the summer of 1997 and analyzed for field properties and inorganic and organic constituents. Results of field-measured properties are listed in table 2. Concentrations of the major ions, calcium, magnesium, sodium, potassium, chloride, sulfate, fluoride, and silica, are listed in table 3. Results of selected nutrient and pesticide analyses are listed in tables 4 and 5, respectively. Quality assurance/quality control data are listed in table 6.

Table 3. Concentrations of major ions in ground-water samples collected in the agricultural land-use study area, lower Coastal Plain of South Carolina, 1997

[Concentrations in milligrams per liter; ND, not detected]

County well number (fig. 1)	Calcium	Magnesium	Sodium	Potassium	Chloride	Sulfate	Fluoride	Silica
ALL383	3.1	11	3.1	0.36	20	0.52	0.12	6.2
ALL384	7.9	7.6	4.1	2.5	16	0.24	ND	6.2
ALL385	6	3.2	15	4.6	16	4.3	0.1	7.4
BAM078	19	12	0.7	4.5	4.3	24	ND	2.2
BAM079	7.4	11	3.2	1.1	15	0.4	ND	6.3
BRK633	45	1	3.6	1.3	6.8	10	ND	8.1
BRK634	3	0.86	4.2	1.6	7.9	1.3	ND	13
BW920	5.4	5.7	2.1	8.3	14	0.55	ND	7.3
CLA067	2.6	2.9	17	2.9	19	0.48	ND	10
COL355	11	6.7	5.5	2.4	16	0.38	ND	13
COL356	39	3.9	2.9	0.82	12	3.3	0.21	4.6
COL357	0.83	2.3	4.7	0.39	11	0.1	ND	7.6
COL358	0.83	1.1	7.9	0.93	23	0.27	ND	12
COL359	13	1.5	15	0.45	23	49	0.37	44
DOR325	30	0.83	6.6	0.5	6.8	0.6	0.22	11
DOR326	1.8	2.5	6.2	1.2	8.9	1.5	ND	7
HAM220	2.3	0.53	7.7	2.3	12	1.8	ND	19
HAM221	0.97	0.7	13	0.56	7.6	0.57	ND	10
HAM222	9.1	10	2.4	0.86	16	0.16	ND	6.8
HAM223	0.37	0.45	3.1	0.38	5.9	0.26	ND	8.6
HAM224	0.97	0.95	4.5	0.13	7.8	1.5	ND	4.9
ORG394	0.61	0.39	6.3	0.17	5.4	0.3	ND	7.2
ORG395	8.7	7.1	40	6	52	16	0.45	26
ORG396	14	6.8	3.2	1.1	16	0.32	0.29	8.3
ORG397	49	1.5	4.5	0.29	6.8	1.6	0.14	5.5
ORG398	3.7	0.36	3.6	0.12	10	0.74	ND	24
ORG399	7.8	5.9	1.9	21	20	0.51	ND	5.3
ORG399*	7.7	6.5	2.0	20	20	0.46	ND	5.4
ORG400	58	1	9.7	0.42	8.6	18	0.13	16
ORG402	1.3	1.9	6.9	0.5	9.6	1	ND	7.1
ORG404	37	1.1	7.1	1.5	12	4	ND	10

*Replicate sample.

Table 4. Concentrations of nutrients in ground-water samples collected in the agricultural land-use study area, lower Coastal Plain of South Carolina, 1997

[Concentrations in milligrams per liter; ND, not detected]

County well number (fig. 1)	Nitrogen, nitrite plus nitrate	Nitrogen, nitrite	Nitrogen, ammonia	Nitrogen, ammonia plus organic	Dissolved phosphorus	Phosphorus, orthophosphate
ALL383	13.0	ND	ND	ND	ND	0.055
ALL384	14.0	ND	ND	ND	ND	0.078
ALL385	12.7	ND	ND	ND	0.025	0.068
BAM078	16.8	ND	ND	ND	ND	ND
BAM079	17.4	ND	ND	ND	ND	ND
BRK633	3.54	ND	ND	ND	0.044	0.054
BRK634	1.40	ND	0.037	ND	0.017	ND
BW920	12.9	ND	ND	ND	ND	0.019
CLA067	9.03	ND	ND	ND	ND	ND
COL355	13.2	ND	ND	ND	ND	ND
COL356	10.1	ND	ND	0.15	0.083	0.101
COL357	2.32	ND	0.015	ND	0.021	0.022
COL358	ND	ND	0.027	ND	ND	ND
COL359	ND	ND	ND	0.35	0.367	0.389
DOR325	4.53	ND	ND	ND	0.019	0.029
DOR326	4.60	ND	ND	ND	ND	ND
HAM220	2.06	ND	0.042	ND	ND	ND
HAM221	6.48	ND	ND	ND	ND	ND
HAM222	16.0	ND	ND	ND	ND	ND
HAM223	ND	ND	ND	ND	ND	ND
HAM224	0.453	ND	ND	ND	ND	ND
ORG394	2.37	ND	ND	ND	ND	ND
ORG395	22.6	0.030	ND	ND	ND	ND
ORG396	18.1	0.054	0.017	ND	ND	ND
ORG397	2.21	ND	ND	ND	ND	ND
ORG398	ND	ND	0.036	ND	0.035	0.040
ORG399	17.3	ND	0.017	ND	ND	ND
ORG399*	18.1	0.01	0.020	ND	ND	ND
ORG400	0.34	0.014	ND	ND	0.013	0.040
ORG402	2.45	ND	0.020	ND	ND	ND
ORG404	6.88	0.02	ND	ND	ND	0.014

*Replicate sample.

Table 5. Concentrations of selected pesticides in ground-water samples collected in the agricultural land-use study area, lower Coastal Plain of South Carolina, 1997

[Concentrations in micrograms per liter; ND, not detected]

County well number (fig. 1)	Detected pesticides
ALL383	Deethyl atrazine (0.003), atrazine (0.002), alachlor (0.002), acetochlor (0.002)
ALL384	Deethyl atrazine (0.019), atrazine (0.014), simazine (0.002), alachlor (0.008), acetochlor (0.002), tebuthiuron (1.9), metolachlor (0.205)
ALL385	Deethyl atrazine (0.005), atrazine (0.004), simazine (0.007), alachlor (0.002), acetochlor (0.002), ethalfluralin (0.005)
BAM078	Deethyl atrazine (0.034), atrazine (0.075), bentazon (11.5), metolachlor (0.018),
BAM079	Deethyl atrazine (0.005), atrazine (0.014)
BRK633	Deethyl atrazine (0.004), atrazine (0.004), dieldrin (0.004)
BRK634	Deethyl atrazine (0.008)
BW920	Deethyl atrazine (0.072), atrazine (0.010), metolachlor (0.041), diazinon (0.005), terbacil (0.03), carbofuran (0.01), diuron (0.02)
CLA067	ND
COL355	Deethyl atrazine (0.005), atrazine (0.003)
COL356	Deethyl atrazine (0.063), atrazine (0.005)
COL357	Deethyl atrazine (0.004)
COL358	ND
COL359	ND
DOR325	Deethyl atrazine (0.002), atrazine (0.002), metolachlor (0.002)
DOR326	Deethyl atrazine (0.019), atrazine (0.011), prometon (0.009)
HAM220	ND
HAM221	Deethyl atrazine (0.004), trifluralin (0.005), tebuthiuron (0.066)
HAM222	Aldicarb sulfone (0.12)
HAM223	ND
HAM224	ND
ORG394	Deethyl atrazine (0.001)
ORG395	Deethyl atrazine (0.001)
ORG396	Metolachlor (0.003)
ORG397	ND
ORG398	Atrazine (0.001)
ORG399	Deethyl atrazine (0.005), atrazine (0.008)
ORG399*	Deethyl atrazine (0.004), atrazine (0.007)
ORG400	ND
ORG402	Fluometuron (0.18)
ORG404	Deethyl atrazine (0.003), atrazine (0.001)

*Replicate sample.

Table 6. Results of quality-assurance and quality-control analyses in ground-water samples collected in the agricultural land-use study area, lower Coastal Plain of South Carolina, 1997

[Samples associated with wells ORG405 and ORG410 were collected during a similar study during the summer of 1997. An asterisk (*) indicates that the value shown is the actual concentration; all other values were less than the listed value because the compound was either absent from the sample or was present in such a small quantity that it could not be quantified. No value listed indicates constituent not sampled. mg/L, milligrams per liter; µg/L, micrograms per liter]

Constituent	County well number			
	ORG405	DOR326	ORG410	ORG402
Nitrogen ammonia, mg/L	0.02		0.023*	0.015
Nitrogen, nitrite, mg/L	0.01		0.01	0.01
Nitrogen ammonia plus organic, mg/L	0.1		0.1	0.2
Nitrogen nitrite plus nitrate, mg/L	0.053*		0.05	0.05
Phosphorus, mg/L	0.01		0.01	0.01
Phosphorus orthophosphate, mg/L	0.01		0.012*	0.01
Calcium, mg/L	0.02	0.02		0.081*
Magnesium, mg/L	0.01	0.01		0.01
Sodium, mg/L	0.2	0.2		0.2
Potassium, mg/L	0.1	0.1		0.1
Chloride, mg/L	0.1	0.1		0.1
Sulfate, mg/L	0.1	0.1		0.1
Fluoride, mg/L	0.1	0.1		0.1
Silica, mg/L	0.01	0.01		0.087*
Manganese, mg/L	1.3*	1		1.6*
Propachlor, µg/L	0.007	0.007		0.007
Butylate, µg/L	0.002	0.002		0.002
Bromacil, µg/L	0.035	0.035		0.035
Simazine, µg/L	0.005	0.005		0.005
Prometon, µg/L	0.018	0.018		0.018
Deethyl atrazine, µg/L	0.002	0.002		0.002
Cyanazine, µg/L	0.004	0.004		0.004
Fonofos, µg/L	0.003	0.003		0.003
Alpha BHC, µg/L	0.002	0.002		0.002
p,p' DDE, µg/L	0.006	0.006		0.006
Dicamba, µg/L	0.035	0.035		0.035
Linuron, µg/L	0.018	0.018		0.018
MCPA, µg/L	0.05	0.05		0.05
MCPB, µg/L	0.035	0.035		0.035
Methiocarb, µg/L	0.026	0.026		0.026
Propoxur, µg/L	0.035	0.035		0.035
Bentazon, µg/L	0.014	0.014		0.014
2,4-DB, µg/L	0.035	0.035		0.035
Fluometuron, µg/L	0.035	0.035		0.035
Oxamyl, µg/L	0.018	0.018		0.018
Chlorpyrifos, µg/L	0.004	0.004		0.004

Table 6. Results of quality-assurance and quality-control analyses in ground-water samples collected in the agricultural land-use study area, lower Coastal Plain of South Carolina, 1997 (Continued)

[Samples associated with wells ORG405 and ORG410 were collected during a similar study during the summer of 1997. An asterisk (*) indicates that the value shown is the actual concentration; all other values were less than the listed value because the compound was either absent from the sample or was present in such a small quantity that it could not be quantified. No value listed indicates constituent not sampled. mg/L, milligrams per liter; µg/L, micrograms per liter]

Constituent	County well number			
	ORG405	DOR326	ORG410	ORG402
Lindane, µg/L	0.004	0.004		0.004
Dieldrin, µg/L	0.001	0.001		0.001
Metolachlor, µg/L	0.002	0.002		0.002
Malathion, µg/L	0.005	0.005		0.005
Parathion, µg/L	0.004	0.004		0.004
Diazinon, µg/L	0.002	0.002		0.002
Atrazine, µg/L	0.001	0.001		0.001
2,4-D, µg/L	0.035	0.035		0.035
2,4,5-T, µg/L	0.035	0.035		0.035
Silvex, µg/L	0.021	0.021		0.021
Alachlor, µg/L	0.002	0.002		0.002
Triclopyr, µg/L	0.05	0.05		0.05
Propham, µg/L	0.035	0.035		0.035
Acetochlor, µg/L	0.002	0.002		0.002
Picloram, µg/L	0.05	0.05		0.05
Oryzalin, µg/L	0.019	0.019		0.019
Norflurazon, µg/L	0.024	0.024		0.024
Neburon, µg/L	0.015	0.015		0.015
1-naphthol, µg/L	0.007	0.007		0.007
Methomyl, µg/L	0.017	0.017		0.017
Fenuron, µg/L	0.013	0.013		0.013
Esfenvalerate, µg/L	0.019	0.019		0.019
DNOC, µg/L	0.035	0.035		0.035
Diuron, µg/L	0.02	0.02		0.02
Dinoseb, µg/L	0.035	0.035		0.035
Dichlorprop, µg/L	0.032	0.032		0.032
Dichlobenil, µg/L	0.02	0.02		0.02
Dacthal, mono-acid, µg/L	0.017	0.017		0.017
Clopyralid, µg/L	0.05	0.05		0.05
Chlorothalonil, µg/L	0.035	0.035		0.035
Chloramben, µg/L	0.011	0.011		0.011
3-hydroxycarbofuran, µg/L	0.014	0.014		0.014
Carbofuran, µg/L	0.028	0.028		0.028
Carbaryl, µg/L	0.008	0.008		0.008
Bromoxynil, µg/L	0.035	0.035		0.035

Table 6. Results of quality-assurance and quality-control analyses in ground-water samples collected in the agricultural land-use study area, lower Coastal Plain of South Carolina, 1997 (Continued)

[Samples associated with wells ORG405 and ORG410 were collected during a similar study during the summer of 1997. An asterisk (*) indicates that the value shown is the actual concentration; all other values were less than the listed value because the compound was either absent from the sample or was present in such a small quantity that it could not be quantified. No value listed indicates constituent not sampled. mg/L, milligrams per liter; µg/L, micrograms per liter]

Constituent	County well number			
	ORG405	DOR326	ORG410	ORG402
Aldicarb, µg/L	0.016	0.016		0.016
Aldicarb sulfone, µg/L	0.016	0.016		0.05
Aldicarb sulfoxide, µg/L	0.021	0.021		0.021
Acifluorfen, µg/L	0.035	0.035		0.035
Metribuzin, sencor, µg/L	0.004	0.004		0.004
2,6-diethylaniline, µg/L	0.003	0.003		0.003
Trifluralin, µg/L	0.002	0.002		0.002
Ethalfluralin, µg/L	0.004	0.004		0.004
Phorate, µg/L	0.002	0.002		0.002
Terbacil, µg/L	0.007	0.007		0.007
Linuron, µg/L	0.002	0.002		0.002
Methyl parathion, µg/L	0.006	0.006		0.006
EPTC, µg/L	0.002	0.002		0.002
Pebulate, µg/L	0.004	0.004		0.004
Tebuthiuron, µg/L	0.01	0.01		0.01
Molinate, µg/L	0.004	0.004		0.004
Ethoprop, µg/L	0.003	0.003		0.003
Benfluralin, µg/L	0.002	0.002		0.002
Carbofuran, µg/L	0.003	0.003		0.003
Terbufos, µg/L	0.013	0.013		0.013
Pronamide, µg/L	0.003	0.003		0.003
Disulfoton, µg/L	0.017	0.017		0.017
Triallate, µg/L	0.001	0.001		0.001
Propanil, µg/L	0.004	0.004		0.004
Carbaryl, µg/L	0.003	0.003		0.003
Thiobencarb, µg/L	0.002	0.002		0.002
DCPA, µg/L	0.002	0.002		0.002
Pendimethalin, µg/L	0.004	0.004		0.004
Napropamide, µg/L	0.003	0.003		0.003
Propargite, µg/L	0.013	0.013		0.013
Methyl Azinphos, µg/L	0.001	0.001		0.001
Permethrin, Cis, µg/L	0.005	0.005		0.005

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